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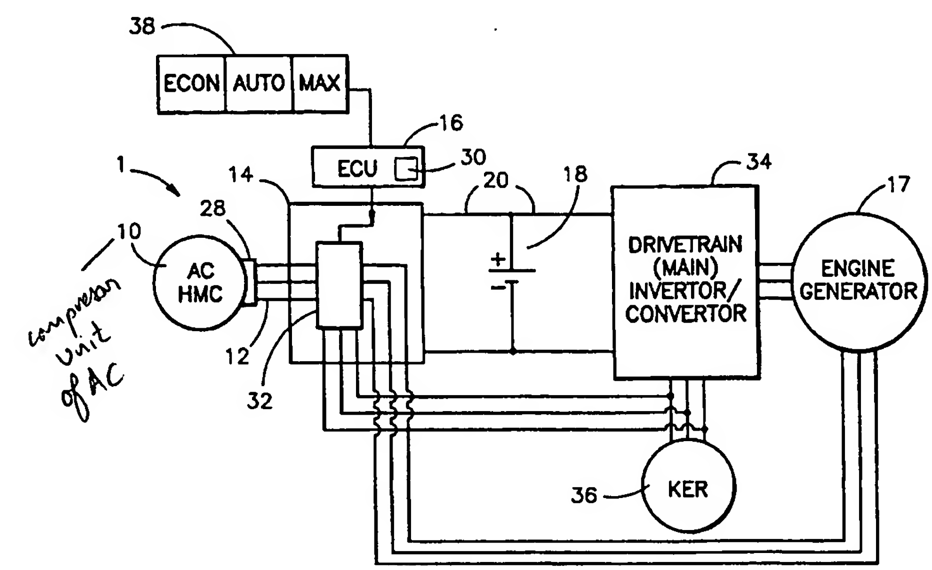
(54) Title: A HYBRID VEHICLE AIR-CONDITIONING SYSTEM



(57) Abstract: A hybrid vehicle air-conditioning system includes a compressor unit (10) for compressing gaseous refrigerant sealed in the air-conditioning system into compressed gaseous refrigerant, a condenser (100) for condensing said compressed gaseous refrigerant into liquified refrigerant by exchanging heat with ambient air, an evaporator (104) for evaporating the refrigerant from the condenser into gaseous refrigerant by exchanging heat with ambient air. The compressor unit includes a compressor (24), an electric motor (26) for driving the compressor and a housing (22) for encasing the compressor and the electric motor in a hermetically-sealed manner. The compressor unit is preferably located at a location remote from a liquid fuel-powered engine of the hybrid vehicle so as to prevent effects of heat and/or vibration of the engine.

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A HYBRID VEHICLE AIR-CONDITIONING SYSTEM

This application claims priority of U.S. Patent application No. 60/168,749 filed on December 6, 1999, the disclosure of which is incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a hybrid vehicle air-conditioning system, and more particularly to, a hybrid vehicle air-conditioning system equipped with a hermetically-sealed electrically-powered compressor.

2. Description of Related Art

Vehicle air-conditioning systems have historically relied upon engine-powered compressors to provide proper cooling for the vehicle passenger compartment. These compressors are powered through a direct mechanical linkage with the vehicle's engine. Although these air-conditioning systems typically perform well while the vehicle's engine is running, nonetheless, these engine-powered air-conditioning systems rely upon the engine power for proper operation. This is problematic, because this reliance on the engine may impede engine power, performance and fuel consumption efficiency during driving periods. Additionally, many engines are not engineered to operate for long periods of time as stationary power generators. This poses problems during long intervals when the engine is running but the vehicle is not being driven.

Just as the engine-powered compressor adversely affects the engine's operation, the engine adversely affects the operation of the engine-powered compressor. The most common adverse effects caused by the engine result

from the position of the compressor with respect to the engine. The engine-powered compressor is mounted on the engine. While running, and for a short time after being shut down, the engine radiates intense heat which is incident upon the engine-mounted compressor. Additionally, the running engine's constant, strong vibrations vibrate the engine-mounted, engine-powered compressor. The heat and vibration tend to decrease the life of the engine-powered compressor and the hardware, including the flexible hose, gaskets, o-rings and the front oil seal, required to attach the engine-powered compressor to the engine.

Prior art discloses many attempts to improve vehicle air-conditioning systems. U.S. Patent No. 5,408,842 to Goto et al. discloses an air-conditioning apparatus for an electrical vehicle, wherein the compressor is driven by a battery.

U.S. Patent No. 5,265,437 to Saperstein discloses an automotive refrigeration system requiring minimal refrigerant, wherein the compressor may be located at a location remote from the liquid fuel-powered engine. When the system is located remote from the engine, the system may be driven by an electrical motor.

U.S. Patent No. 4,641,502 to Aldrich et al. discloses a roof mounted air conditioner for recreational vehicles. The air conditioner includes a hermetically sealed air conditioner compressor and an electric motor.

U.S. Patent No. 5,199,274 to Yoshida et al. discloses an automotive air-conditioning apparatus having a motor-compressor driven by an engine via a generator and a drive device.

In the meantime, in a hybrid vehicle, a liquid fuel-powered engine is provided together with an electric motor

for driving the vehicle. Accordingly, an air-conditioning system for use in such a hybrid vehicle relies upon an engine-powered compressor to provide proper air conditioning for the vehicle passenger compartment in the same manner as in a conventional liquid fuel-powered engine vehicle air-conditioning system.

Therefore, a conventional hybrid vehicle air-conditioning system has the same drawbacks as in the conventional engine-powered air-conditioning system because the hybrid vehicle air-conditioning system relies upon a conventional engine-powered compressor.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an air-conditioning system which is preferably used in a hybrid vehicle, which can minimize refrigerant leakage to thereby protect the environment.

It is another object of the present invention to provide a hybrid vehicle air-conditioning system which does not adversely affect the engine's operation of the hybrid vehicle.

It is still another object of the present invention to provide a high efficient hybrid vehicle air-conditioning system which can reduce fuel consumption and engine burden in a hybrid vehicle while having less-expensive manufacturing costs and a longer life span than conventional air-conditioning systems.

According to the present invention, a hybrid vehicle air-conditioning system includes a compressor unit for compressing gaseous refrigerant into compressed gaseous refrigerant, a condenser for condensing the compressed gaseous refrigerant into liquified refrigerant by exchanging heat with ambient air, an evaporator for

evaporating the liquefied refrigerant from the condenser into gaseous refrigerant by exchanging heat with ambient air, and piping for interconnecting components of the air-conditioning system including the compressor, the condenser and the evaporator. The compressor unit includes a compressor, an electric motor for driving the compressor and a housing for encasing the compressor and the electric motor in a hermetically-sealed manner.

With this air-conditioning system, since the compressor is driven by the electric motor, the compressor does not adversely affect the engine's operation and can avoid the heat and vibration of the engine, resulting in a minimized refrigerant leak, which in turn effectively protects the global environment.

The compressor unit may be mounted on any convenient portion of a chassis or body of the hybrid vehicle.

It is preferable that the compressor unit is located at a location remote from an engine of the hybrid vehicle so as to avoid heat and vibration generated by the engine.

Preferably, the electric motor is an AC motor, more preferably, a three-phase induction motor.

Other objects and the features of the present invention will be apparent from the following detailed description of the invention with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be more fully described and better understood from the following description, taken with the appended drawings, in which:

Figure 1 is a perspective view of a prior art air-conditioning system in a hybrid vehicle;

Figure 2 is a perspective view showing a hybrid

vehicle air-conditioning system according to an embodiment of the present invention;

Figure 3 is a block diagram of the aforementioned embodiment of the present invention;

Figure 4 is a schematic view showing the hermetically-sealed compressor unit employed in the embodiment of the present invention; and

Figure 5 is a block diagram of the present invention interfaced with several of the vehicle's existing power distribution components.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The detailed embodiment of the present invention is disclosed herein. It should be understood, however, that the disclosed embodiment is merely exemplary of the invention, which may be embodied in various forms. Therefore, the details disclosed herein are not to be interpreted as limited, but merely as the basis for the claims and as a basis for teaching one skilled in the art how to make and/or use the invention.

With reference to Figure 1, a perspective view of a prior art air-conditioning system in a hybrid vehicle is shown. The prior art air-conditioning system includes a condenser 100 positioned near the front of the vehicle in the normal vicinity of the vehicle's radiator. The system also includes an engine-driven compressor 102 and an evaporator core 104.

The engine-driven compressor 102 is mechanically attached to the vehicle's engine and driven by the vehicle's engine via a compressor drive belt 110. During engine operation, the engine's vibrations vibrate the engine-driven compressor 102, and heat generated by the engine heats the engine-driven compressor 102. The tension

on the compressor drive belt 110 caused by the engine-driven compressor 102 affects the engine performance. Similarly, the engine's vibrations and heat affects the operation and longevity of the engine-driven compressor 102.

Because the engine-driven compressor 102 vibrates and moves due to engine vibrations and movements, the engine-driven compressor 102 is attached to the condenser 100 and the evaporator core 104 via segments of flexible hose and rigid tube 106. The flexible hose 106 transports refrigerant to the components of the air-conditioning system. As the vehicle and the air-conditioning system are used, the vibration and movement of the engine and the engine-driven compressor 102 affects the performance of the flexible hose 106, causing refrigerant leaks which adversely affect the environment. This leakage is a minimized by the present invention.

Referring to Figure 2, a perspective view of the embodiment of the present invention in a hybrid vehicle is disclosed. Similar to the prior art air-conditioning system, the preferred embodiment includes a condenser 100 positioned near the front of the vehicle in the normal vicinity of the vehicle's radiator. Like the prior art, the preferred embodiment also includes an evaporator core 104 mounted near the vehicle passenger area. Unlike the prior art, the preferred embodiment includes an AC hermetic motor compressor (AC HMC) 10 and segments of rigid tube 108. The AC HMC 10 and the segments of rigid tube 108 replace the prior art engine-driven compressor 102, segments of flexible hose 106 and compressor drive belt 110.

Still referring to Figure 2, when installed in a vehicle, the AC HMC 10 may be attached to any convenient

place of the chassis or body of the vehicle. The AC HMC 10 is preferably located at a location remote from the engine so as to avoid the heat and vibration generated by the engine. For example, the AC HMC 10 may be located at the passenger compartment side. As will be understood from the above, it is not necessary to mount the AC HMC 10 in the engine room. The other components required for proper operation of the present invention, as will be discussed below, may be mounted at a convenient location on the vehicle with respect to the AC HMC 10. The configuration of the preferred embodiment eliminates the need for the conventional flexible air-conditioning hoses, compressor clutch, belts, pulleys, massive mounting brackets and related parts.

Eliminating the conventional belts and drive components eliminates the mechanical loss on the engine caused by the compressor. Also, the hermetically-sealed configuration of the AC HMC 10, as discussed in detail below, without the flexible external hoses and drive components, reduces refrigerant loss from leakage or seepage by 75% over conventional engine-driven compressors. Finally, mounting the AC HMC 10 on the vehicle chassis or body prevents the intense heat and vibrations of the engine from adversely affecting the operation and life span of the AC HMC 10. In the present invention, the life span of the AC HMC 10 may be up to twice as long as the life span of a conventional engine-driven compressor. Thus, the location and configuration of the preferred embodiment of the present invention enhances the performance of both the vehicle engine and the AC HMC 10.

Referring again to Figure 2, the AC HMC 10 is connected to the condenser 100 and to the evaporator core 104 via the segments of rigid tube 108. The rigid tube 108

transports refrigerant between the various components of the air-conditioning system. Structurally, the rigid tube 108 is superior to the flexible hose 106, and, in the preferred embodiment, the rigid tube 108 is not subjected to the vibrations caused by the engine and an engine-driven compressor 102. Therefore, the preferred embodiment also minimizes refrigerant leaks from the rigid tube 108 which adversely 5 affect the environment.

9 With reference to Figure 3, a block diagram of an electrically-powered air-conditioning system 1 comprising the AC hermetic motor compressor (AC HMC) 10 of the present invention is disclosed. The electrically-powered air-conditioning system 1 also comprises an AC power cable 12, a DC to AC inverter 14, an electronic control unit (ECU) 16, an engine generator 17 directly connected to and driven by a crankshaft of an engine (not shown) of the vehicle and a DC power source 18. 17

The DC power source 18 of preferably 100-575 V provides DC voltage to the DC to AC inverter 14 via a DC power cable 20. Although a hybrid DC power source 18 is preferred, any equivalent power supply may be substituted for the hybrid DC power source 18 without jeopardizing the spirit of the invention.

The DC to AC inverter 14 is a common machine, device or system that changes DC voltage into AC and also modulates a desired variable frequency. The inverter comprises commonly-used solid-state silicon controlled rectifiers (SCR's) or power transistors that convert the voltage from DC to AC. The inverter used in the preferred embodiment includes 4 power transistors for single-phase AC conversion and 6 transistors for three-phase AC conversion.

The generator 17 outputs an AC voltage to drive the AC HMC 10 when the engine is running. Thus, the AC HMC 10 can

be powered only by the output of the generator 17 directly driven by the vehicle's engine.

In this embodiment, the AC HMC 10 is also powered by the output of the invertor 14. The following is a detailed explanation of the operation of the AC HMC 10 powered by the output of the invertor 14. Based upon operating instructions provided to the DC to AC inverter 14 from the ECU 16, the DC to AC inverter 14 converts the DC voltage to AC required by the AC HMC 10 for proper operation. The DC to AC inverter 14 then supplies the output AC to the AC HMC 10 via the AC power cable 12.

The ECU 16 is a computer system which, in addition to controlling other functions of the vehicle heating, ventilation and air-conditioning (HVAC) system, also controls the DC to AC inverter 14. In general, the ECU 16 monitors signals received 10 from vehicle sensors and from the driver's controls. The sensor signals may be related to inside and outside temperatures, as well as other conditions. The ECU 16 utilizes these input signals to control various air circulation devices, including blower motors, vacuum solenoids, engine cooling fans, the DC to AC inverter 14 and the AC HMC 10.

Specifically, when controlling the DC to AC inverter 14 and the AC HMC 10, the ECU 16 engages a frequency converter device 30, contained within the ECU 16, with the DC to AC inverter 14. The frequency converter device 30 controls the output frequency of the AC provided by the DC to AC inverter 14. By controlling the AC frequency provided to the AC HMC 10 via the frequency converter device 30 the speed of the compressor motor can be infinitely varied. Thus, depending upon the desired vehicle cabin temperature the motor speed can be controlled in order to deliver more or less cooled air in a given time

period.

In addition to requiring varied frequencies to operate at various levels, to increase operating efficiency, the AC HMC 10 requires high voltage and three-phase voltage or single-phase voltage. The desired voltage is within the 100-575 volt range. However, 120 volts or 240 volts is most preferred, because the majority of the world's AC motors operate on a nominal voltage of 120 volts or 240 volts. The majority of the world's industrial AC motors also operate on three-phase AC. Three-phase AC motors are simple in construction, require little maintenance and cost less to operate than single-phase or DC motors. Thus, utilizing a three-phase AC HMC 10 that operates on 120 volts or 240 volts decreases manufacturing costs and increases operating efficiency.

Referring to Figure 4, a block diagram of the AC HMC 10 is disclosed. The AC HMC 10 comprises an airtight, hermetically-sealed housing 22 having external, leakproof electrical connections 28. The hermetically-sealed housing 22 encases a compressor unit 24 and an AC motor 26, wherein the AC motor 26 drives the compressor unit 24 directly. This requires a motor with exceptional power characteristics. The AC motor 26 is preferably a three-phase AC induction motor which has no physical electrical connections to the rotor. This configuration reduces motor wear and minimizes the need for maintenance on the AC motor 26. While the preferred embodiment in Figure 4 shows the compressor unit 24 positioned above the AC motor 26, the motor 26 may be positioned above the compressor unit 24 without affecting the operation of the present invention.

Because of the hermetically-sealed housing 22, external motors are not appropriate for the present

invention. Additionally, because of the requirement for a direct drive motor with exceptional power characteristics, motors using rotor windings requiring either brushes or slip rings cannot be used. However, development of the capacitor motor and the split-phase motor enables a single-phase AC hermetic motor to substitute for the preferred hermetic three-phase AC motor 26.

In operation, the AC motor 26 is typically considered a constant speed motor. This is because the synchronous speed of an induction motor is based on the supply frequency and the number of poles in the motor winding. Thus, for example, motors designed for 60 Hz use have synchronous speeds of 3600, 1800, 1200, 900, 720 and 600 rpm.

To calculate the synchronous speed of an induction motor, the following formula is applied:

$$rpm_{syn.} = 120f/Np$$

where rpm_{syn} = synchronous speed (in rpm) , f = supply frequency (in cycles/sec), and Np = number of motor poles. As is evident by the above formula, the supply frequency and the number of motor poles are the only variables that determine the speed of the AC motor 26. Therefore, to change the operating speed of the AC motor 26, either the number of poles in the AC motor 26 must be changed, or the frequency of the AC supplied to the AC motor must be changed.

In the present invention, the AC HMC 10 has a greater cooling capacity as the speed of the AC motor 26 increases. In contrast, the AC HMC 10 cools less as the speed of the AC motor 26 decreases. Additionally, the speed of the AC motor 26 varies directly, in a continuously adjustable range of speeds, with the frequency of the AC provided by the DC to AC inverter 14, as controlled by the frequency

converter device 30. Thus, increasing the frequency of the AC will increase the cooling provided by the AC HMC 10, and decreasing the frequency of the AC will decrease the cooling provided by the AC HMC 10.

With reference to Figure 5, a block diagram is shown of the preferred embodiment of the present invention interfaced with the HV's existing power distribution components. As seen in Figure 5, the HV's power distribution components include a drive train inverter/converter 34 and a kinetic energy regenerator (KER) 36. Additionally, the preferred embodiment includes an operator selector switch 38 interfaced with the ECU 16, and the DC to AC inverter 14 includes an inverter relay 32 controlled by the ECU 16. In this embodiment, the engine generator 17 directly driven by an engine (not shown) of the vehicle is electrically connected to the drive train inverter/convertor 34 and the inverter relay 32. As discussed in detail below, the inverter relay 32 connects the engine generator 17 and/or the KER 36 to the AC HMC 10 during certain operating conditions.

The drive train inverter/converter 34 is the main inverter of the HV. The drive train inverter/converter 34 is connected to the DC power supply 18 via the DC power cable 20. Also, the drive train inverter/converter 34 is connected to the KER 36 and other vehicle components. In operation, the drive train inverter/converter 34 converts direct current from the vehicle's DC power supply 18 into alternating current to drive the vehicle's electric driving motor, and also converts alternating current from the engine generator 17 and the KER 36 into direct current to charge the vehicle's DC power supply 18.

In the present invention, the DC to AC inverter 14 is a secondary inverter operating only with the HV's

electrically-powered air-conditioning system 1 in the automatic mode which will be explained later. The DC to AC inverter 14 has a smaller operating capacity than the drive train inverter/converter 34, preferably 1.5 kw. As discussed in detail above, the DC to AC inverter 14 provides the operating AC to the AC HMC 10.

Referring again to Figure 5, the HV includes the KER 36. The KER 36 is connected to the drive train inverter/converter 34, the inverter relay 32 and other vehicle components including the vehicle's braking system. During vehicle operation, the KER 36 reclaims energy from the wheels during deceleration, braking and downhill driving. The reclaimed energy is transmitted to the drive train inverter/converter 34 or, in the present invention, to the drive train inverter/converter 34 and the inverter relay 32, where the reclaimed energy is converted into electricity to charge the DC power supply 18 and/or directly power the AC HMC 10. When the reclaimed energy is transmitted only to the drive train inverter/converter 34 and used to recharge the DC power supply 18, approximately 30% of the reclaimed energy is lost during the drive train inverter/converter 34 operation. Thus, approximately 70% of the reclaimed energy is used to recharge the DC power supply 18.

In operation, the electrically-powered air-conditioning system 1 performs in one of three modes. The three modes are the economy mode, the automatic mode and the maximum mode. A user determines the operating mode via the operator selector switch 38, preferably located within the vehicle passenger area. The selected mode of operation is input from the operator selector switch 38 to the ECU 16. The ECU 16 then controls the operating mode via the DC to AC inverter 14 based on the position of the

operator selector switch 38 and other inputs to the ECU 16, including the temperature inside the vehicle.

In the economy mode, the regenerated energy from the KER 36 is directly provided to the AC HMC 10 via the inverter relay 32, as controlled by the ECU 16. When the vehicle is at rest no power is supplied to the AC HMC 10, thus creating a more economic operating mode. The remainder of the energy from the KER 36 is delivered to the drive train inverter/converter 34 and is used to power other vehicle components or to recharge the DC power supply 18.

In the automatic mode, the AC HMC 10 receives operating power from the DC power supply 18 via the DC to AC inverter 14.

During the maximum mode, the AC HMC 10 receives operating power from the engine generator 17 directly driven by the crankshaft of the engine (not shown). Like the economy mode, the output of the electrically-powered air-conditioning system 1 is controlled by the speed of the AC motor 26 which is controlled by the frequency of the AC supplied to the AC HMC 10.

While the electrically-powered air-conditioning system 1 utilizes power from the DC power supply 18, the power reclaimed by the KER 36 and/or the power from the engine generator 17, the system also operates very efficiently. Typical vehicle air-conditioning systems, which are engine-driven and depend upon the engine speed for operation, are 3 ton (36,000 Btu/hr.) air-conditioning systems. The present invention, which is electrically-powered and does not depend upon the engine speed for operation, is a 1 ton (12,000 Btu/hr.) unit. Thus, the present invention achieves equivalent or better results with a smaller capacity unit.

With a conventional engine driven compressor the horsepower required to drive the compressor varies with the engine speed, thereby requiring horsepower demands as large as 8 hp to produce 48,000 BTU's and as low as 2 hp to produce 12,000 BTU's. Whereas, with the AC HMC 10 of the present insertion the horsepower required to drive the compressor motor does not depend upon engine speed. In view of this fact a smaller more efficient compressor can be used to generate the require cooling capacity for vehicles.

While the preferred embodiment has been shown and described, it will be understood that there is no intent to limit the invention by such disclosure, but rather, it is intended to cover all modifications and alternate constructions falling within the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. A hybrid vehicle air-conditioning system, comprising:

a compressor unit for compressing gaseous refrigerant into compressed gaseous refrigerant;

a condenser for condensing said compressed gaseous refrigerant into liquified refrigerant by exchanging heat with ambient air;

an evaporator for evaporating said liquefied refrigerant from said condenser into gaseous refrigerant by exchanging heat with ambient air; and

piping for interconnecting components of said air-conditioning system including said compressor, said condenser and said evaporator,

wherein said compressor unit includes a compressor, an electric motor for driving said compressor and a housing for encasing said compressor and said electric motor in a hermetically-sealed manner.

2. The hybrid vehicle air-conditioning system as recited in claim 1, wherein said compressor unit is mounted at any convenient location on a chassis or body of said hybrid-vehicle.

3. The hybrid vehicle air-conditioning system as recited in claim 2, wherein said compressor unit is located at a location remote from an engine of said hybrid vehicle so as to avoid heat and vibration generated by said engine.

4. The hybrid vehicle air-conditioning system as recited in claim 1, wherein said electric motor is an AC motor or a variable speed brushless DC motor.

5. The hybrid vehicle air-conditioning system as recited in claim 4, wherein said AC motor is a three-phase induction motor or a single-phase motor.

6. The air-conditioning system as recited in claim 1, further comprising:

a DC power source for driving a driving motor for said vehicle and said electrical motor;

a first inverter for converting direct current of said DC power source into alternative current required by said compressor unit; and

an electronic control unit for controlling said first inverter.

7. The air-conditioning system as recited in claim 6, wherein said electronic control unit includes a frequency converter device for controlling a frequency of an output alternative voltage of said first inverter, whereby a rotational speed of said electric motor is controlled.

8. The air-conditioning system as recited in claim 6, further comprising:

a second inverter/converter connected to said DC power source;

a kinetic energy regenerator electrically connected to said second inverter/converter; and

an inverter relay provided in said first inverter,

wherein said second inverter/converter converts direct current from said DC power source into alternating current to drive a driving motor for said vehicle and converts alternating current from said kinetic energy regenerator into direct current to charge said DC power supply and/or to drive said compressor unit,

wherein said inverter relay electrically connects said kinetic energy regenerator with said electric motor constituting said compressor unit based on an instruction of said electronic control unit, whereby reclaimed energy reclaimed by said kinetic energy regenerator during deceleration, braking and/or downhill driving of said vehicle is directly transmitted to said electric motor constituting said compressor unit.

9. The air-conditioning system as recited in claim 1, wherein said electric motor constituting said compressor unit is driven by a power of an engine generator directly connected to a crankshaft of an engine of said hybrid vehicle.

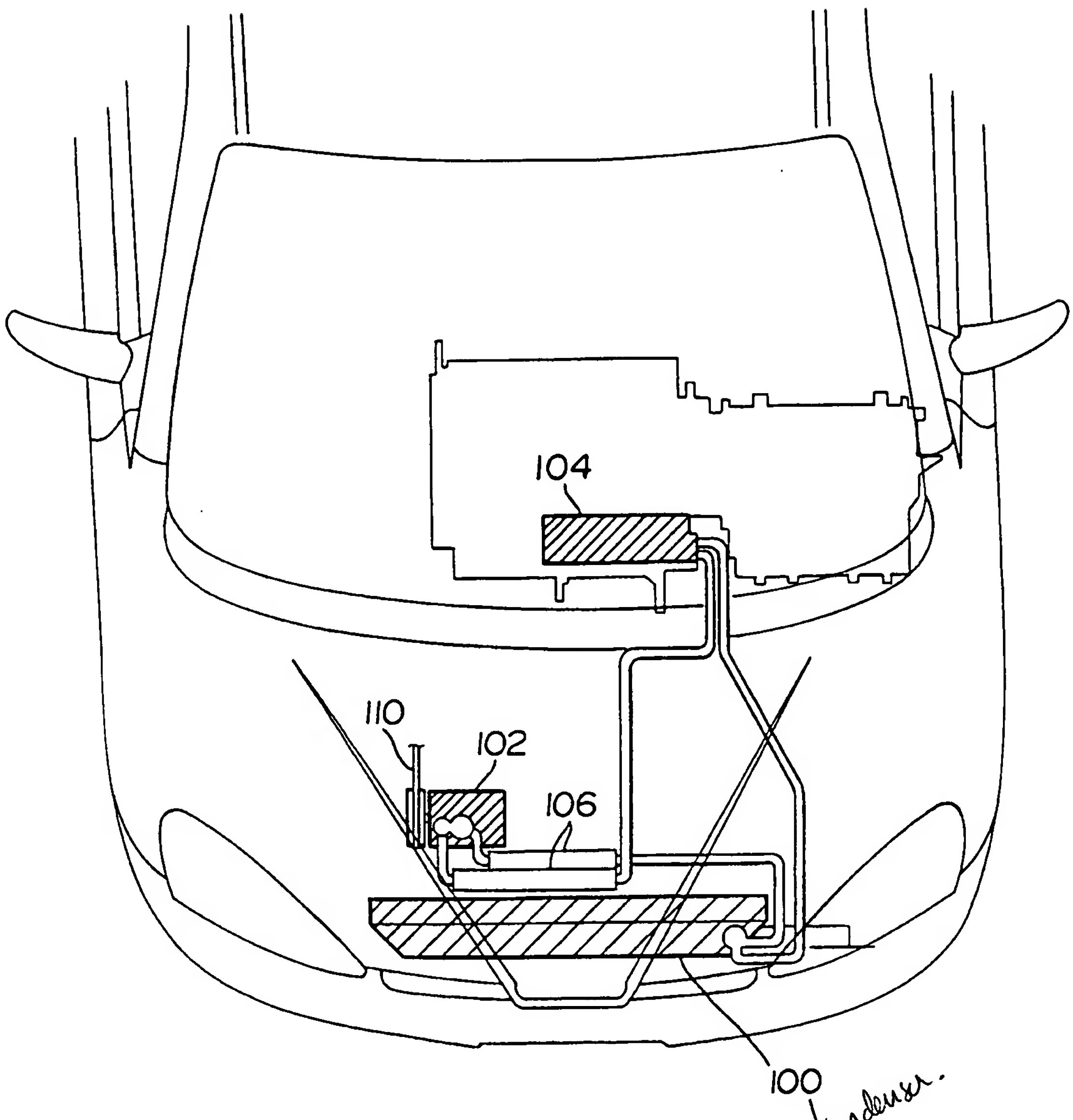

FIG. 1
PRIOR ART

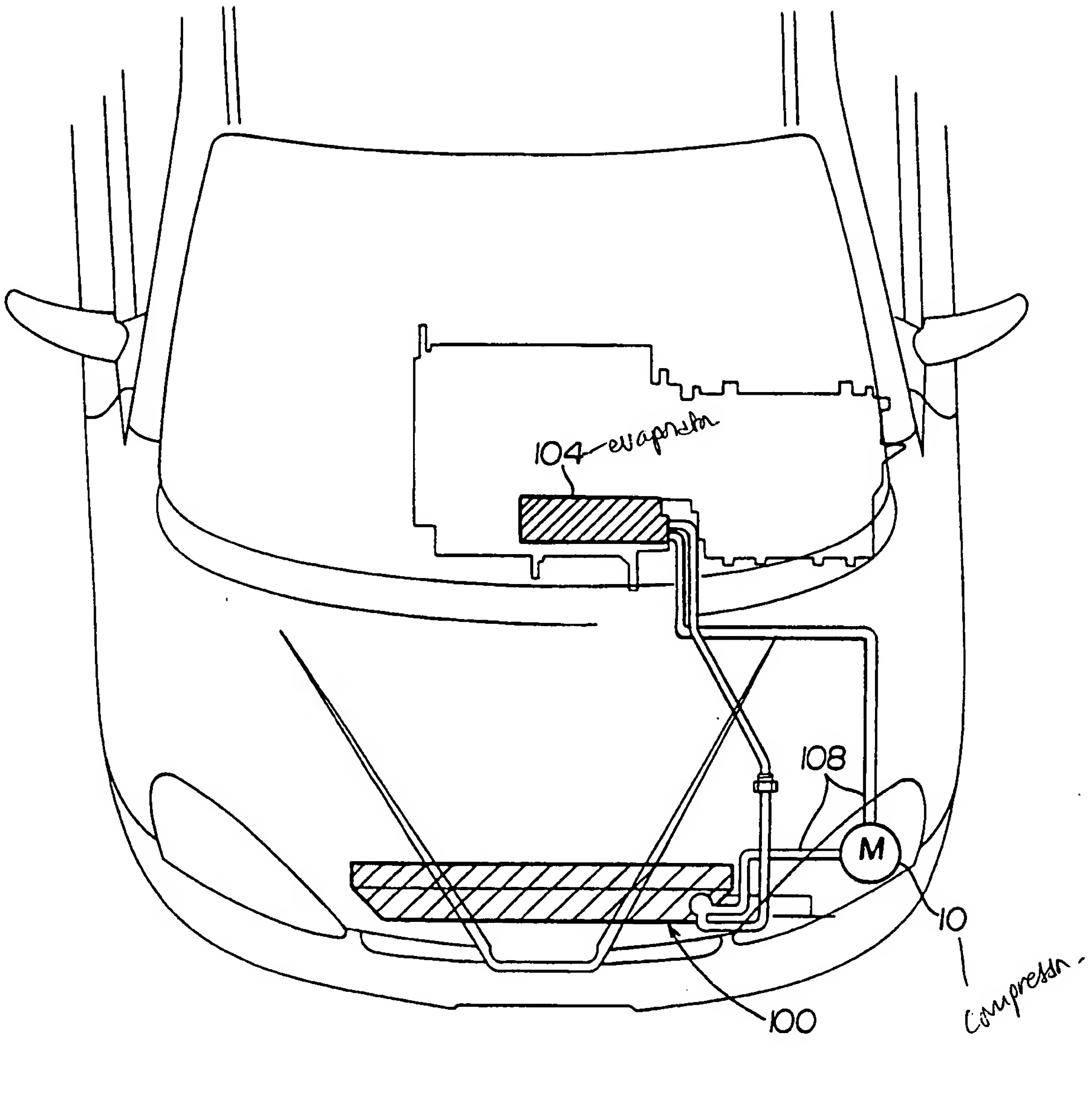

FIG. 2

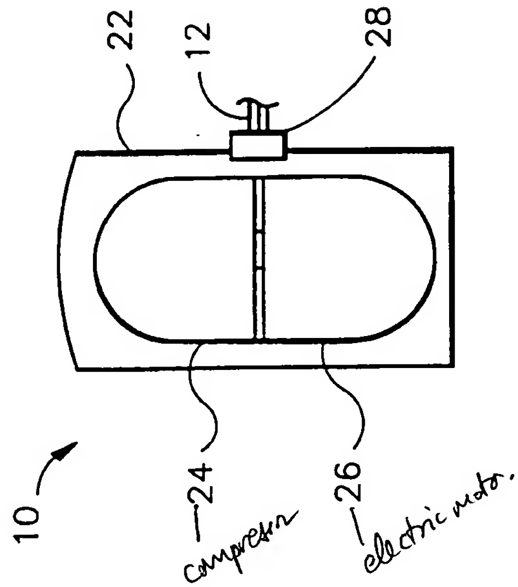
22
12
28
10
24
compressor
26
electric motor.

FIG. 4

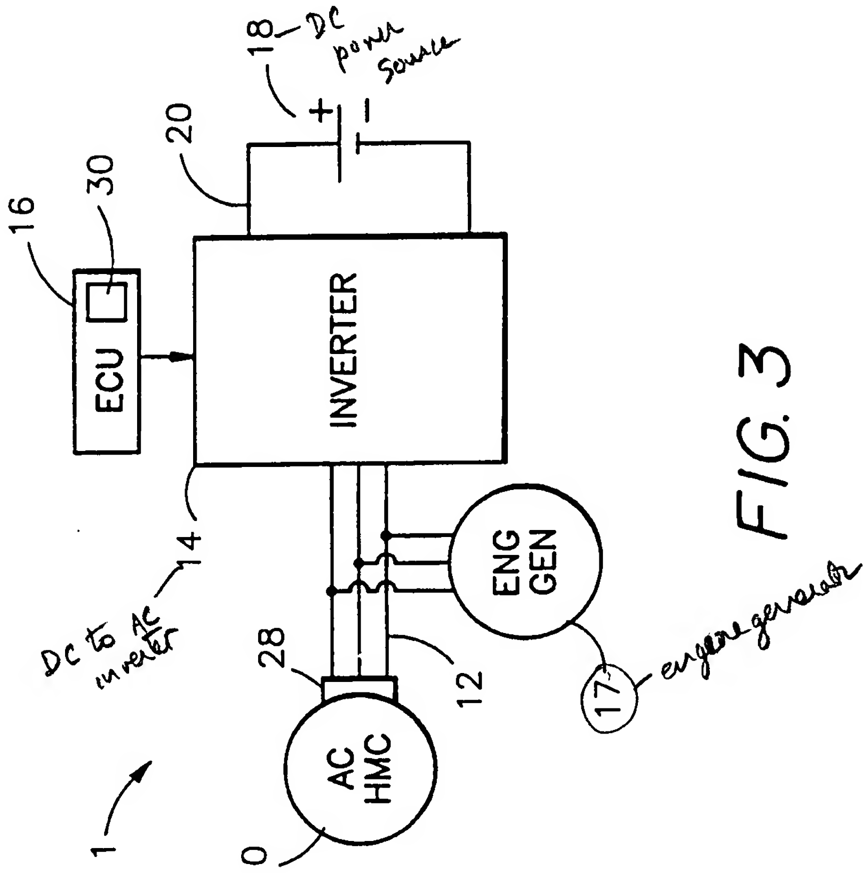
16
30
ECU
20
18
DC power source
+
-
INVERTER
14
DC to AC inverter
28
12
ENG GEN
17
engine generator
AC HMC
10
1

FIG. 3

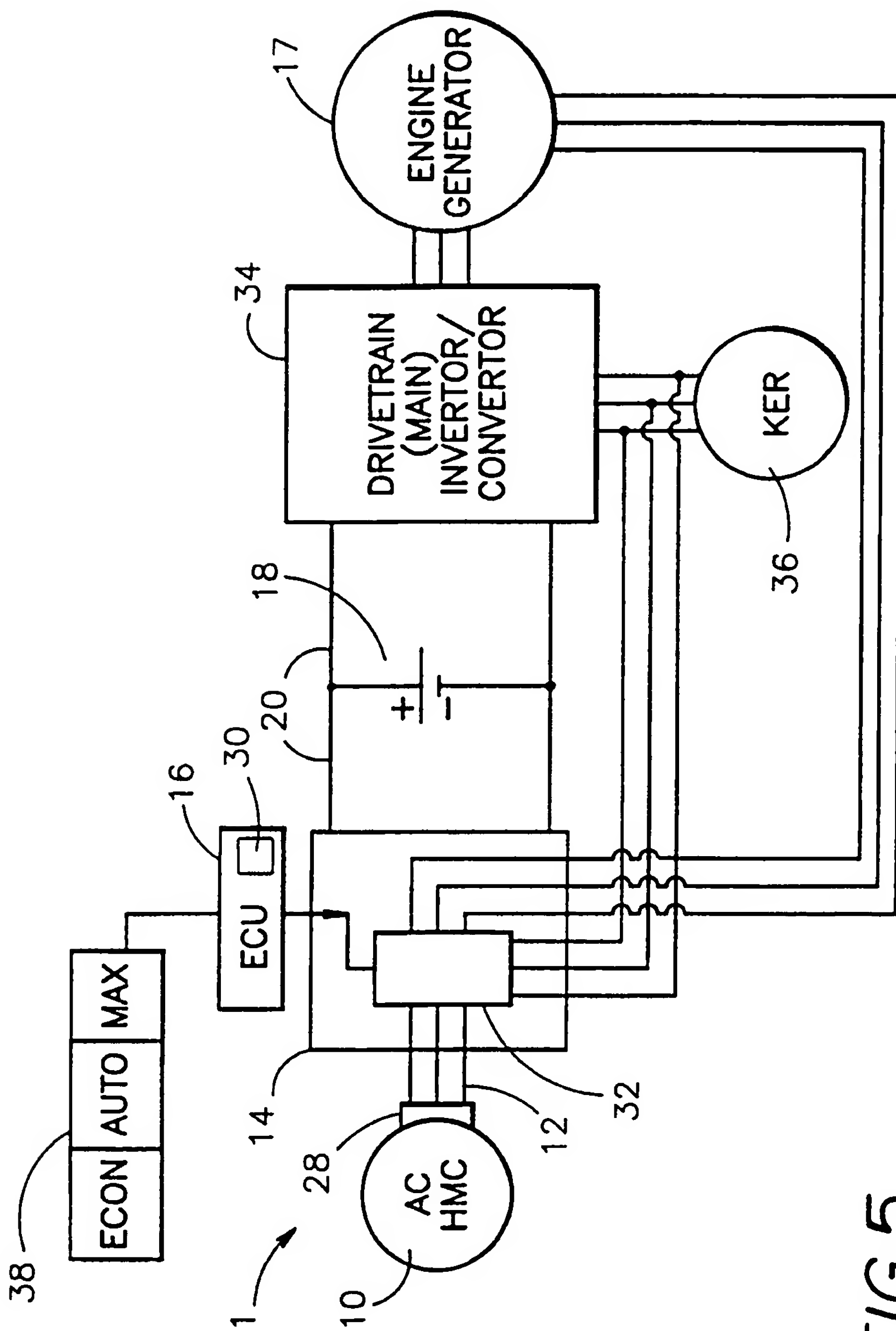
17
ENGINE
GENERATOR
34
DRIVETRAIN
(MAIN)
INVERTOR/
CONVERTOR
KER
36
18
20
+
−
16
30
ECU
38
ECON
AUTO
MAX
14
28
12
32
AC
HMC
10
1

FIG.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/33054

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : B60H 1/32
US CL : 62/236, 244, 323.3

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 62/236, 244, 323.3, 323.2

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
None

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Please See Continuation Sheet

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 5,927,089 A (O'DONNELL) 27 July 1999, column 6, lines 46-58.	1-6 ----- 9
X --- Y	US 4,667,480 A (BESSLER) 26 May 1987, column 3, lines 30-38.	1 and 4-6 -------------- 2, 3, 9
Y	US 5,896,750 A (KARL) 27 April 1999, column 2, lines 49-62.	9
A	US 3,941,012 A (MAYER) 02 March 1976, see the entire document.	1-9
A	US 5,222,372 A (DEREES et al) 29 June 1993, see the entire document.	1-9
A	US 5,226,294 A (MAYER) 13 July 1993, see the entire document.	1-9
A	US 4,909,046 A (JOHNSON) 20 March 1990, see the entire document.	1-9

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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Date of the actual completion of the international search 30 January 2001 (30.01.2001)	Date of mailing of the international search report 30 MAR 2001
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703)305-3230	Authorized officer Michael Buiz Diane Smith for Telephone No. (703) 308-0975

Form PCT/ISA/210 (second sheet) (July 1998)

Continuation of B. FIELDS SEARCHED Item 3: EAST
search terms: compressor with mount$ with chassis